

REMARKS

Claim 11 has been amended. No new matter is being introduced by the current amendment.

Upon entry of this amendment, claims 1-3, 5-7, and 9-22 will be pending.

Withdrawal of Previous Rejections

Applicants acknowledge the withdrawal of the rejection of claim 11 under 35 U.S.C. §112, second paragraph, and the rejections under 35 U.S.C. §102(b) based on U.S. Patent No. 4,032,458 (Cooley et al.), GB 1,437,898 (Schwartz et al.) and U.S. Patent No. 5,210,296 (Cockrem et al.) set forth in the Office action dated December 12, 2007.

Claim Objection

Applicants respectfully request reconsideration of the objection to claim 11 as having improper grammar. Applicants submit that the present amendment to claim 11 obviates the objection.

Rejections Under 35 U.S.C. §103

Claim 1 is directed to a process for the diesterification of C<sub>4</sub> dicarboxylic acids by reaction of the dicarboxylic acid with methanol in the presence of water of solution. The process comprises:

- (a) providing a solution comprising the dicarboxylic acid and the water of solution;
- (b) reacting the solution of the dicarboxylic acid in an esterification zone with methanol to form an ester and water of esterification, the esterification being conducted

at temperatures of from 65 to 150°C and pressures from 1 to 5 bar in a two-stage process;

(c) removing the water of solution and the water of esterification; and

(d) recovering the ester.

**Cooley et al. and Turner et al.**

Applicants respectfully request reconsideration of the rejection of claims 1-3, 5, 10-12 and 16-21 under 35 U.S.C. §103(a) as unpatentable over Cooley et al. in view of U.S. Patent No. 4,751,334 (Turner et al.).

Cooley et al. disclose a process for preparation of 1,4-butanediol that includes preparation of a dialkyl ester of maleic acid by reacting maleic acid with a monohydric alcohol having from 2 to about 10 carbons. (See col. 2, lines 46-49). Claim 1 of the instant application requires, *inter alia*, reacting a dicarboxylic acid with methanol. Nowhere do Cooley et al. disclose utilizing methanol for preparation of the dialkyl ester of maleic acid.

The Office responds to applicants' previous arguments by asserting that Cooley et al. do not exclude from their invention the use of methanol as the monohydric alcohol. However, the text of Cooley et al. states precisely that a suitable monohydric alcohol has "from 2 to about 10 carbon atoms" and that "preferred monohydric alcohols are those which form a heterogeneous azeotrope with water." Cooley et al. list n-butanol, primary isoamyl alcohol and n-amyl alcohol as suitable monohydric, azeotrope-forming alcohols (See, col. 2, lines 46-57). Applicants point out that in the above-quoted teaching from the primary reference, the word "about" does not precede

"2", but does precede "10." Cooley et al. further disclose that with respect to the esterification process, "[t]he necessary operating pressure will be highest whenever the dehydrating agent is ethanol and will decrease as the molecular weight of the monohydric alcohol increases" (See, for example, col. 4, lines 10-13). This statement is consistent with the teaching in the primary reference that the monohydric alcohol has "from 2 to about 10 carbon atoms" and makes it clear that Cooley et al. exclude the use of methanol in their process and anticipate that the monohydric alcohol employed will always contain at least two carbon atoms (i.e., ethanol results in the highest esterification operating pressure). Thus, the monohydric alcohol is selected such that it forms an azeotrope with water and invariably has at least 2 carbon atoms. Given this disclosure, one skilled in the art would understand that (1) Cooley et al. specifically exclude use of methanol as the monohydric, esterification alcohol; (2) the selection of methanol is contrary to the teaching in Cooley et al.; and (3) use of methanol in the process of Cooley et al. would not allow practice of the disclosed process including azeotropic distillation with any reasonable expectation of success.

The Office further asserts that the teaching in Cooley et al. to select an alcohol that forms an azeotrope with water does not exclude methanol since it would be obvious to add acetonitrile, thereby forming a ternary azeotropic mixture to aid in the removal of water. Applicants fail to understand the relevance of this unsupported assertion.

Cooley et al. teach that monohydric alcohols suitable for the process described therein are those that form an azeotrope with water. Methanol does not. The Office has misconstrued the

disclosure of Cooley et al. and applicants' previous arguments. Cooley et al. teach (1) that the esterification alcohol be selected to form an azeotropic mixture with water; (2) a higher preference for the selection of esterification alcohols that form a heterogeneous azeotrope with water, which forms two immiscible layers upon condensation; and (3) the necessity of adding a third component to the condensed distillation overhead to form a heterogeneous ternary azeotropic mixture to aid in separation when the alcohol selected forms a homogeneous azeotropic mixture with water (See, for example, col. 2, lines 42-57 and col. 5, lines 19-28). The purpose of introducing a third component to a binary homogeneous azeotropic mixture in Cooley et al. is to form a ternary heterogeneous azeotrope mixture that upon condensation forms two immiscible, more easily separable layers. However, for a mixture of methanol and water no azeotrope is formed and the teaching in the primary reference regarding addition of a third component is inapposite. Moreover, the claimed process does not require the introduction of a third component such as acetonitrile and the Office fails to articulate why one skilled in the art would first, contrary to the teaching of the primary reference, select a monohydric alcohol that does not form an azeotrope with water and then introduce acetonitrile into the binary non-azeotropic mixture of methanol and water in an attempt to form a ternary azeotropic mixture. Such an unsupported modification of the primary reference would arguably make separation more costly and difficult requiring additional reagents and process steps. In any event, Cooley et al. teach that the monohydric alcohols suitable for the process described therein are those that form an azeotrope with water and the prior art does not teach or

suggest that this express preference could be avoided with a binary non-azeotropic mixture by introducing a third component into the non-azeotropic mixture.

In a preferred embodiment employing n-butanol as the monohydric alcohol, Cooley et al. teach that the operating pressure is from "about 55 to about 80 psig" (approximately 3.8 to 5.5 bar) in order to maintain a temperature in the lower portion of the distillation column at a temperature of from about 175° C to about 235° C (See col. 4, lines 14-20). Claim 1 of the instant application requires, *inter alia*, reacting a dicarboxylic acid with methanol and performing the esterification process at pressures ranging from 1 to 5 bar and at temperatures from 65° C to 150° C. Accordingly, one skilled in the art applying the teaching in Cooley et al. with respect to the relationship between the molecular weight of the monohydric alcohol and the esterification operating pressure as stated above, would expect the operating pressure to increase as the molecular weight of the monohydric alcohol decreases. In other words, according to the teaching in Cooley et al., the operating pressure for methanol would be greater than 3.8 to 5.5 bar. However, contrary to this teaching, applicants have discovered that methanol can be employed and the esterification process operated at lower pressures of 1 to 5 bar and at temperatures from 65° C to 150° C. One skilled in the art attempting to modify Cooley et al. would not have arrived at the process conditions set forth in claim 1 and it is respectfully submitted that the claimed invention is not obvious in view of Cooley et al. for this additional reason.

The deficiencies in the primary reference cannot be overcome by resort to Turner et al.

Turner et al. disclose preparation of 1,4-butanediol by the vapor phase hydrogenolysis of an alkyl ester of a C<sub>4</sub> dicarboxylic acid utilizing a reduced copper-chromium or copper-zinc mixed oxide catalyst. Nowhere do Turner et al. disclose utilizing methanol for preparation of the alkyl ester of the dicarboxylic acid. The only mention of methanol is in connection with dilution of the ester to provide the dehydrogenation feedstock (See, for example, col. 4, lines 61-63). Accordingly, the disclosure of Turner et al. does not cure the deficiencies of the primary reference and the combination of references relied on by the Office fails to establish a *prima facie* case of obviousness with respect to the process of claim 1.

In view of the above, it is respectfully submitted that claim 1 is patentable over the disclosure of Cooley et al. in view of the disclosure of Turner et al. It is further respectfully submitted that claims 2, 3, 5, 10-12 and 16-21 that depend directly or indirectly from claim 1 are likewise patentable over this combination of references for the reasons set forth above regarding claim 1 and for the additional limitations which they introduce.

Schwartz et al. and Cockrem et al.

Applicants respectfully request reconsideration of the rejection of claims 1, 2, 5-7, 9-15, and 20-22 under 35 U.S.C. §103(a) as unpatentable over Schwartz et al. in view of Cockrem et al.

Schwartz et al. disclose a process for the preparation of maleic acid esters that comprises reacting maleic acid with a monohydric alcohol. Schwartz et al. generally disclose a wide array of primary, secondary and tertiary monohydric alcohols

having from one to 18 carbon atoms may be employed and an equally expansive range of esterification operating conditions. However, Schwartz et al. teach that C<sub>4</sub> to C<sub>18</sub> (more preferably C<sub>4</sub> to C<sub>8</sub>) primary alcohols are preferred (See, for example, page 2, lines 102-107 and page 3, lines 9-23 and lines 48-63) and only provide working examples for n-butanol (C<sub>4</sub>) and n-hexanol (C<sub>6</sub>), both alcohols falling within the preferred teaching. Schwartz et al. teach away from using methanol by stating that preferred alcohols will not be completely soluble with water and will have a boiling point from 100 to 200° C (See, for example, page 2, lines 110-111 and lines 119-121). By contrast, methanol is fully miscible with water and has a boiling point of about 65° C.

On page 9 of the Office action, the Office asserts that one skilled in the art would have found it obvious to select any alcohol that is described by Schwartz et al. as capable of being used in their invention. However, the Office must consider the disclosure of Schwartz et al. with due regard to all of the relevant teachings in the prior art. In *In re Kuderna and Phillips*<sup>1</sup>, the CCPA stated:

We must approach the issue of patentability in terms of what would have been obvious to one of ordinary skill in the art at the time the invention was made **in view of the sum of all the relevant teachings in the art**, not in view of first one and then another of the isolated teachings in the art.

Further, MPEP 2145 states that "[t]he totality of prior art must be considered, and proceeding contrary to accepted wisdom in the art is evidence of nonobviousness.<sup>2</sup> Accordingly, the disclosure

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<sup>1</sup> 426 F.2d 385, 165 USPQ 575 (C.C.P.A. 1970) (emphasis added).

<sup>2</sup> See MPEP Section 2145(X)(D)(3) (8th ed. rev. 7), citing *In re Hedges*, 783 F.2d 1038 (Fed. Cir. 1986).

in Schwartz et al. cannot be considered in isolation, but must be considered in view of all relevant teachings. In particular, the disclosure of Schwartz et al. must be considered in view of Cooley et al., which is especially relevant and related prior art. Stone D. Cooley is named as a co-inventor in both of these references assigned to Petro-Tex Chemical Corporation. The application that issued as GB 1,437,8928 (Schwartz et al.) was filed December 5, 1974, while the application that issued as U.S. Patent No. 4,032,458 (Cooley et al.) was filed later on August 8, 1975.

One skilled in the art considering the relevant teachings from Cooley et al. and Schwartz et al. would find that initially Schwartz et al. disclosed that the monohydric alcohols that may be employed are generally primary, secondary, and tertiary alcohols having from one to 18 carbon atoms. Later, Cooley et al. specifically limited the monohydric alcohols to those containing "from 2 to about 10 carbon atoms." Therefore, one skilled in the art considering the sum of the teaching of these two references would conclude that the exclusion of methanol from the later-filed Cooley et al. reference as indicating that methanol was not a suitable monohydric alcohol for use in the esterification process.

The Examiner suggests that since Schwartz et al. includes temperatures and pressure ranges that overlap those claimed, it would be obvious for the skilled person to optimize the reaction conditions. However, as noted above, applicants claimed process is more than mere optimization. Indeed, if one looks at the sum of the teaching of the two primary references, there is no expectation that the esterification reaction will work at all for methanol, let alone that it would be obvious to alter

pressure and temperature conditions to optimize the reaction conditions. The cited art fails to disclose or suggest the specific selection of utilizing methanol for preparation of the alkyl ester of the dicarboxylic acid while conducting the esterification process at pressures of 1 to 5 bar and at temperatures from 65° C to 150° C as required by claim 1. What the applicant's have discovered is that at a relatively narrow temperature range and pressure range, the esterification reaction can be efficiently conducted using methanol as the monohydric alcohol and in the presence of water of solution. The very fact that this reaction can be successfully conducted at all is an unexpected result. In any event, nothing in the disclosure of Schwartz et al. (particularly when viewed in light of the later disclosure in Cooley et al.) would have motivated a person skilled in the art to select methanol, nor attempt to identify the claimed operating conditions that allow the use of methanol as the monohydric alcohol in the esterification process. The fact that applicants worked contrary to the accepted teachings in the prior art to arrive at the process as defined in claim 1 evinces a finding of nonobviousness.

Cockrem et al. discloses a process for recovery of lactate ester or lactic acid that comprises esterifying lactic acid (i.e., a C<sub>3</sub> monocarboxylic acid) with an alcohol containing 4 to 5 carbon atoms (See, for example col. 5, lines 32-35 of Cockrem et al.). Cockrem et al. fail to disclose the reaction of a dicarboxylic acid with methanol under any conditions. It is respectfully submitted that the secondary reference cannot be relied on to cure the deficiencies of the primary reference and the combination of references relied on by the Office fails to establish a *prima facie* case of obviousness as to claim 1.

In view of the above, it is respectfully submitted that claim 1 is patentable over the disclosure of Schwartz et al. in view of the disclosure of Cockrem et al. It is further respectfully submitted that claims 2, 5-7, 9-15, and 20-22 that depend directly or indirectly from claim 1 are not obvious in view of this combination of references for the reasons set forth above regarding claim 1 and the additional limitations which they introduce.

Favorable reconsideration and allowance of all pending claims are respectfully requested.

The Commissioner is authorized to charge any fee deficiency or overpayment in connection with this amendment to Deposit Account No. 19-1345.

Respectfully submitted,

/Vincent M. Keil/

Vincent M. Keil, Reg. No. 36,838  
SENNIGER POWERS LLP  
100 North Broadway, 17th Floor  
St. Louis, Missouri 63102  
(314) 231-5400

VMK/PDT